

# Remote sensing estimates of impervious surfaces for hydrological modelling of changes in flood risk during high-intensity rainfall events

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# Remote sensing estimates of impervious surfaces for hydrological modelling of changes in flood risk during high-intensity rainfall events

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## Abstract

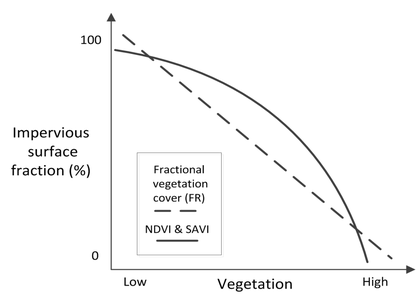
This paper addresses the accuracy and applicability of medium resolution (MR) remote sensing estimates of impervious surfaces (IS) for urban land cover change analysis. Landsat-based vegetation indices (VI) are found to provide fairly accurate measurements of sub-pixel imperviousness for urban areas at different geographical locations within Europe, and to be applicable for cities with diverse morphologies and dissimilar climatic and vegetative conditions. Detailed data on urban land cover changes can be used to examine the diverse environmental impacts of past and present urbanisation, including the importance of such changes for the exposure of cities towards the occurrence and impacts of climate extremes like high-intensity rainfall events.

## INTRODUCTION

Impervious surfaces (IS) such as road infrastructure, buildings and other paved areas typically dominate urban environments (Weng, 2012) and subsequently are often used as an indicator of urbanisation (Angel et al., 2011). IS may generally be defined as man-made surfaces through which water cannot infiltrate. The quantity and location of impervious surfaces within urban areas are important for the hydrological response during high-intensity rainfall as it affects the amount and velocity of run-off, and consequently influences the exposure of cities towards flooding (Arnold and Gibbons, 1996). For this reason past and present city development patterns may prove to have had (and will continue to have) important implications for the exposure of urban systems to the risk of flooding. At the same time, climate change is expected to increase the frequency and intensity of extreme rainfall events in many locations and thus further increase the exposure of cities to flooding (Intergovernmental Panel on Climate Change, 2012). Increased knowledge of the importance of both urban land cover changes and climate change for the risk of urban areas towards flooding will provide substantial insight to city administrations and governments in how to plan for future climate proof cities.

## METHODOLOGY

Information on the extent and quantity of vegetation cover is used to provide estimates of sub-pixel imperviousness for several urban areas in Europe. This is based on the assumption of a strong inverse relationship between vegetation cover and impervious surface, i.e. it is implicitly assumed that non-impervious surfaces within urban areas are covered with green vegetation.

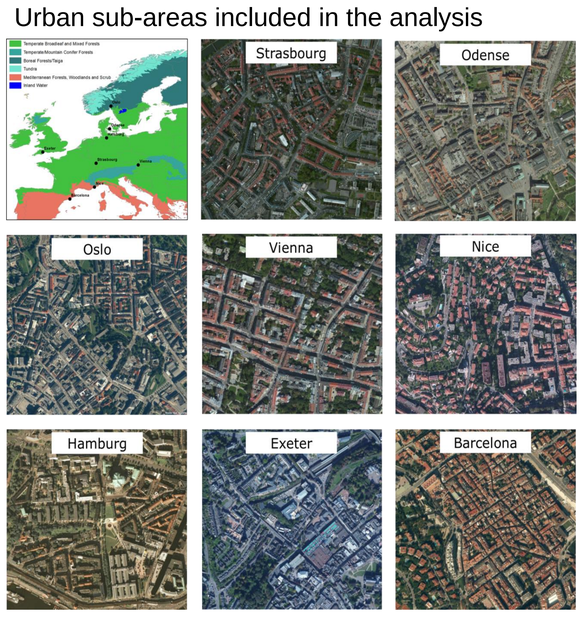



Three different Landsat-based datasets (NDVI, SAVI and fractional vegetation cover) have been developed based on information on vegetation cover from the Landsat 8 sensor. Eight cities are analyzed in the following, representing the major vegetative and climatic conditions in Europe. The accuracy and spatial transferability potential of the three methods are evaluated at 30m spatial resolution. Landsat satellite imagery is publicly available and covers the period from 1972 and onwards.

# IMPERVIOUS SURFACE MAPPING

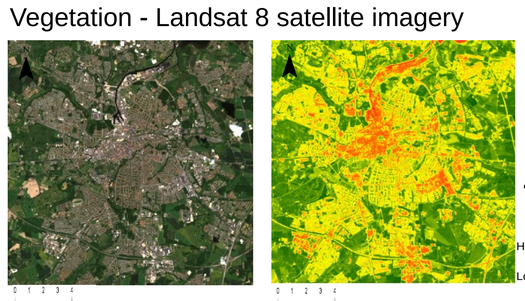
### STUDY AREAS

Urban sub-areas included in the analysis

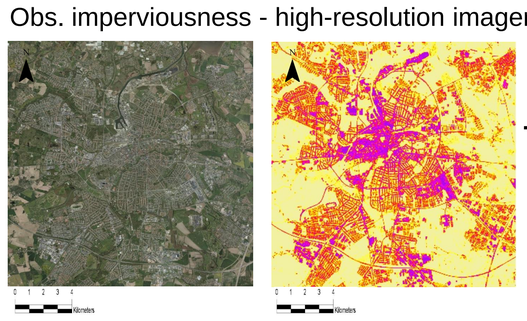



### DATA & ANALYSIS PROCEDURES

Vegetation - Landsat 8 satellite imagery

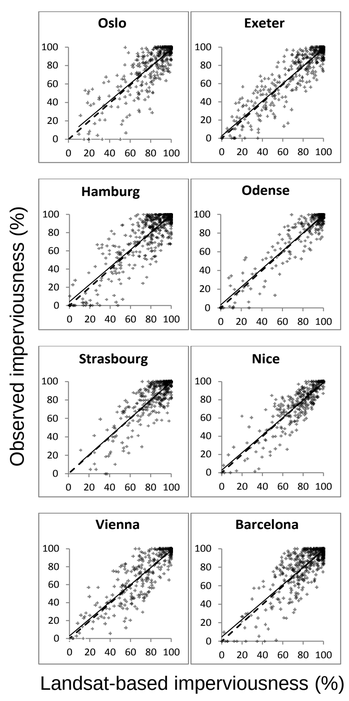


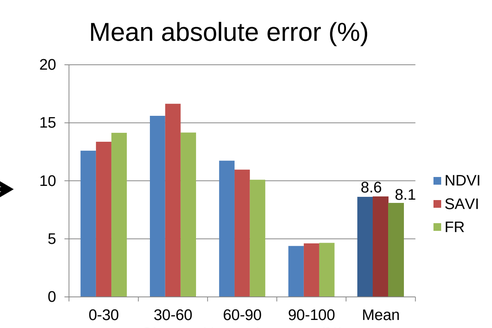

Obs. imperviousness - high-resolution imagery

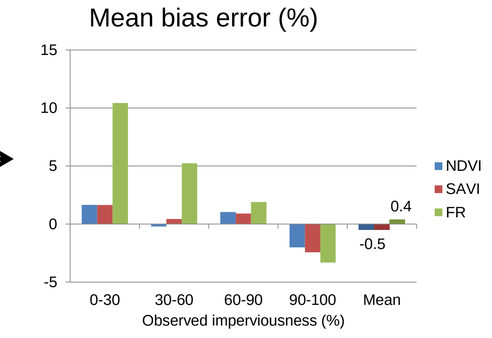



Regression modelling

### ACCURACY ASSESSMENT



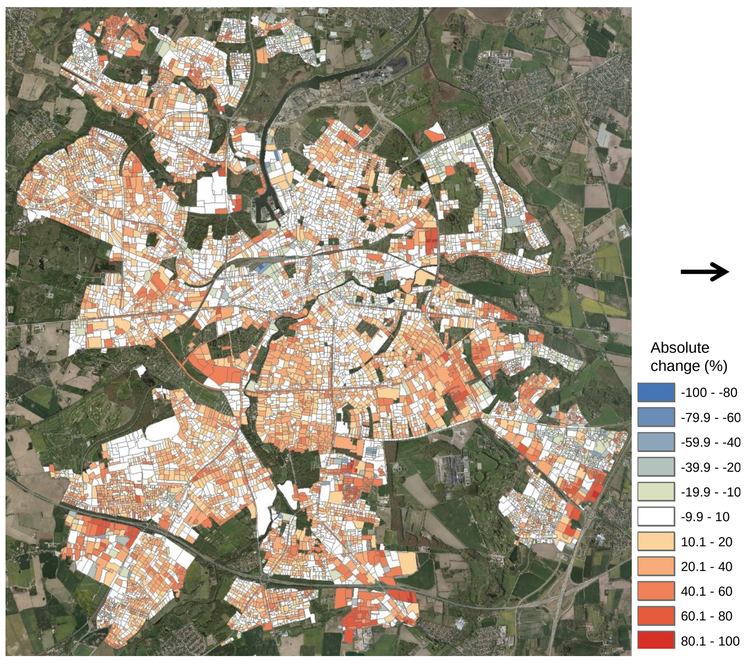



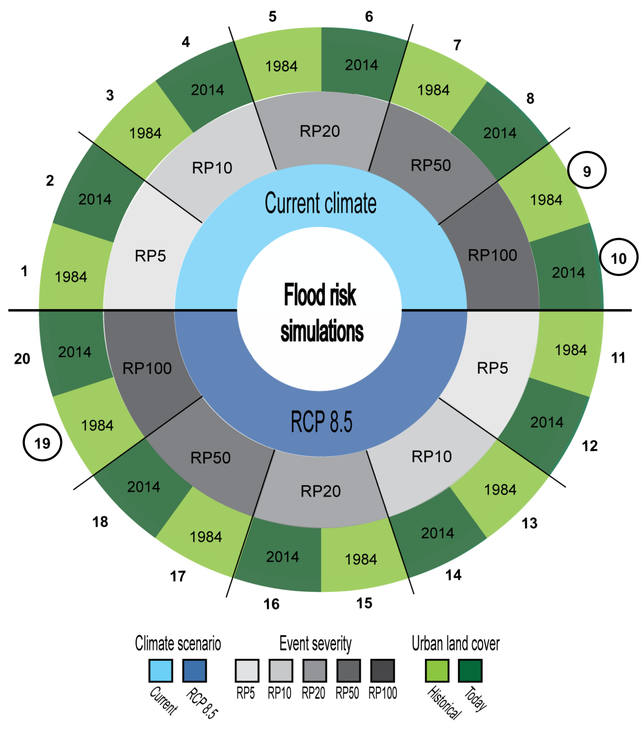

# IMPACT OF URBANISATION ON FLOOD RISK (ongoing work)

### LAND COVER CHANGE ANALYSIS

Change in imperviousness- City of Odense 1984-2014

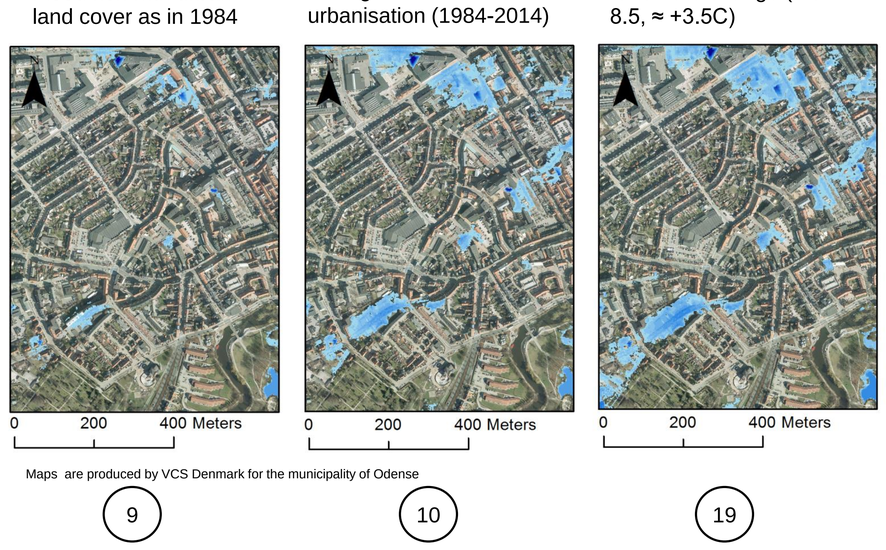



### OVERVIEW OF FLOOD MODEL SIMULATIONS




### FLOOD HAZARD MAPPING

Flooding in the city of Odense during high-intensity rainfall occurring once every 100 years (RP100)




# CONCLUSION

As major European urban areas are almost exclusively characterized by a combination of impervious surfaces and green vegetation, information on vegetation cover from remote sensors can be utilised to provide accurate and cost-efficient estimates of the quantity and spatial distribution of impervious surfaces and changes herein. Such information is useful for a wide range of applications including analysis of the importance of urbanisation for the exposure of cities towards the occurrence and impacts of climate extremes, such as flooding during high-intensity rainfall events.

## References

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